Protocol Development Summary

Protocol: Intensive Understory and Overstory Composition of Forest Vegetation [short name: Intensive Forest Vegetation]

Parks Where Protocol will be Implemented: MORA, NOCA, and OLYM

Justification/Issues being addressed:
Several global and regional threats to forest structure (i.e., anthropogenic climate change, atmospheric and precipitation chemistry, introduced pests, pathogens, and invasive species) may alter species and stand structure, thereby changing the physical quality and quantity of habitat for wildlife. In addition, the chemistry of inputs to aquatic systems may be altered due to changing rates of ecosystem processes. Vegetation is an integrative indicator of environmental conditions, and the composition of understory vegetation is sensitive to finer changes to environment than overstory vegetation. Therefore, understory vegetation may provide an earlier indication of change than overstory. The network will gain extensive information about coarse-scale aspects of forest structure from remote sensing, but no information concerning understory plants. Tree recruitment, growth and mortality are also sensitive indicators of environmental change that generally cannot be detected with remote sensing. Structure and composition of forest vegetation ranked 15 overall in the NCCN.

Specific Monitoring Objectives to be Addressed by the Protocol:
1. Use FIA data to the maximum degree possible to describe decadal changes in under- and over-story structure and composition (see below for description). There may be one or two common vegetation communities that are abundant enough across the network to have sufficient power to detect change in understory vegetation. We expect that there will be more forest types with useful data for overstory vegetation given the lower natural variability of overstory measurements. **Justification:** *Taking advantage of data collected by others is obviously desirable. Overstory data will undoubtedly be useful, and we will investigate the statistical power of understory data.*
2. Determine 7-yr changes in species composition and abundance of forest vegetation in three sets of intensively monitored permanent plots. The three sets of plots will be established in examples of three extreme environments throughout the network (i.e., warm-wet in Olympic and cold-dry in Mount Rainier and North Cascades National Parks. **Justification:** *The high-elevation environments may be the most sensitive to various stressors (e.g., climate change and atmospheric deposition), but due to their small area, they will be under-sampled by FIA plots. The relatively warm-wet environment on the western side of Olympic National Park will provide a contrast to the cold, dry environments sampled in the other two parks. It also comprises the winter feeding grounds of Roosevelt elk (which are also included in the NCCN monitoring program) and is mentioned prominently in the Park's enabling legislation.*
3. Determine 7-yr changes in species composition and abundance of forest vegetation in three sets of permanent plots in one common vegetation class across the three parks. In addition to collecting intensive and statistically powerful understory structure and composition data, we can also take a closer look at forest processes (e.g., tree growth and mortality) than would be possible via FIA. **Justification:** *Monitoring examples of the same vegetation class in all parks will describe the region-wide pattern of the effects of environmental change.*
4. Determine changes in rates of nutrient cycling in the three sets of permanent vegetation plots. **Justification:** *Nutrient cycles link forest vegetation with other ecosystems (e.g., aquatic systems) and will indicate when changes in atmospheric chemistry and/or species composition are altering forest ecosystems in a way that will impact other ecosystems.*

Basic Approach:
We will make use of two sets of permanent plots: an extensive set operated by the USDA Forest Service that represents a systematic, sparse sample; and an intensive set established as part of the NCCN Vital Signs Monitoring, representing a well-replicated sample of a small number of strategically-selected forest types. The Forest Service plots are part of the Forest Inventory and Analysis program, with the goal of documenting the extent and condition of forest resources across all ownerships, and analyze how these resources change over time. With approximately one plot every 6000 acres (excluding ice, rock and water), we estimate there are 200 FIA plots in network parks. Plots are measured once every 10 years. Information collected on each plot includes:

- Tree diameter, length, damage, amount of rotten or missing wood, and tree quality
- Counts of tree regeneration
- General land use
- Stand characteristics such as forest type, stand age, and disturbance
- Changes in land use and general stand characteristics
- Estimates of growth, mortality, and removals (determined by revisiting every 10 years)
- Vegetation diversity and structure
- Down woody debris

The systematic sample is likely to include many plots of common forest types, but relatively few plots of forests at environmental extremes which may be most sensitive to various stressors. Also, based on our pilot studies, understory measurements on each plot may be insufficiently detailed for early detection of change. However, we have contracted for a power analysis to determine whether one or two common vegetation communities are abundant enough across the network to detect change.

We will also establish a network of plots to intensively sample forest types selected to represent environmental extremes as well as a common vegetation class across all three parks. We will monitor forest parameters in permanently marked plots using appropriately sized subplots for classes of vegetation (herbs, shrubs, trees). Abundance will be estimated using cover. We will sample 18 plots per set in panels of 3 that are visited for 2 consecutive years and rested for 4. The number of plots per set and our temporal sampling plan is based on power analysis of pilot data. Parameters to be monitored include:

- Understory structure and composition, including exotics (i.e, cover by species)
- Overstory structure (i.e., live/dead bole biomass, crown volume, crown closure, crown health, stocking density, species composition, size distribution)
- Tree recruitment
- Tree mortality
- Growth of mid-sized trees
- Litter depth – because it is a crude indicator of nutrient processes
- Other nutrient processes (i.e., a subset of soil CO2, N-mineralization, ground water chemistry; details are not yet available)

Principal Investigators and NPS Lead:
Protocol development will be conducted by NPS in collaboration with USGS-FRESC. Principal investigators will be Steve Acker , NPS lead (360-565-3073) and Andrea Woodward, USGS (206-526-6282 x. 332).

Development Schedule, Budget, and Expected Interim Products:

We have contracted for recommendations for a temporal sampling frame and expect results by spring of 2005. Summaries of pilot studies investigating the feasibility and effectiveness of monitoring forest processes and the effect of phenology on the timing of vegetation sampling will be completed. The protocol will be field tested in summer 2005 and finalized in 2006. Expected products include reports recommending a temporal sample frame, methods for monitoring forest processes, and describing the effect of phenology on vegetation sampling. Total cost of protocol development: $160, 000.

Implementation Cost: $95,000 per year